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Cephalometric assessment of maxillary length in Serbian children with skeletal class III

Kefalometrijska procena dužine maksile kod srpske dece sa skeletnom klasom III

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Abstract

Background/Aim. Malocclusion of skeletal class III is a complex irregularity of sagittal inter-jaw relationship, which is due to irregularities of sagittal position of one or both of the jaw bones, which is often associated with disproportionate ratio of their length. The aim of this study was to determine whether the length of the jaw of children with skeletal class III in the period of mixed dentition was changed. **Methods.** Fifty children with skeletal class III and the same number of those with skeletal class I, of both sexes, have been selected on the basis of cephalometric analysis of profile tele-x-ray of the head. All the children aged 6–12 had mixed dentition, and were divided according to sex and age into three subgroups within each group. The length of maxilla, mandible and cranial base were measured. Proportions among the lengths measured within each group were found and difference significance in the measured lengths and their proportions among groups and subgroups were evaluated. **Results.** The children with skeletal class III, compared with the findings in the control group, had significantly lower values of maxillary length, total maxillary length, as well as lower values of their lengths in proportion to lengths of the front or the total length of cranial base and in proportion to mandibular lengths ($p < 0.05$). Among the patients of different sexes, both in the test and the control group, a significant difference in the values of the measured lengths was found. **Conclusion.** The children with skeletal class III have significantly shorter maxilla than those with skeletal class I.

Key words:
cephalometry; maxilla; child; serbia; malocclusion, angle class III.

Apstrakt

Uvod/Cilj. Malokluzija skeletne klase III je kompleksna nepravilnost sagitalnog međuviličnog odnosa, koji nastaje usled nepravilnosti sagitalnog položaja jedne, ili obe vilične kosti, što je često udruženo sa neproporcionalnim odnosom njihovih dužina. Cilj ove studije bio je da se utvrdi da li je kod dece sa skeletnom klasom III u doba mešovite denticije izmenjena dužina gornje vilice. **Metode.** Pedesotoro dece sa skeletnom klasom III i isto toliko sa skeletnom klasom I, oba pola, selekcionisano je na osnovu kefalometrijske analize profilnih telerendgenskih snimaka glave. Sva deca su imala mešovitu denticiju, bila su starosti 6–12 godina i podeljena su prema polu i uzrastu na tri podgrupe u svakoj grupi. Merene su dužine maksile, mandibule i kranijalne baze. Utvrđivane su proporcije između izmerenih dužina unutar svake grupe i procenjivana značajnost razlika izmerenih dužina i njihovih proporcija između grupa i podgrupa. **Rezultati.** Kod dece sa skeletnom klasom III, u poređenju sa nalazom u kontrolnoj grupi, utvrđene su značajno manje vrednosti dužine tela maksile, totalne dužine maksile, kao i manje vrednosti njihovih dužina proporcionalno dužinama prednje, odnosno totalne dužine kranijalne baze i proporcionalno dužinama mandibule ($p < 0,05$). Između ispitanika različitog pola, i u ispitnoj i u kontrolnoj grupi, utvrđena je značajnost razlike za vrednosti merenih dužina. **Zaključak.** Kod dece sa skeletnom klasom III, maksila je značajno kraća nego kod dece sa skeletnom klasom I.

Ključne reči:
kefalometrija; maksila; deca; srbija; malokluzija, anglova klasa III.

Introduction

Malocclusion of skeletal class III is a complex irregularity of sagittal inter-jaw relationship, which is due to irregularities of sagittal position of one or both of the jaw bones. Position irregularity of the jaw bones is often associated with disproportionate ratio of their length. One of the most common components present in the facial morphology

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of patients was insufficient development of middle face, with consequently lower maxillary length, which is why some authors suggest that the anatomical structure itself was a decisive factor for classifying patients with malocclusion class III [1–5]. During the development of human fetuses, studies show that the central part of facial complex is clearly distinguishable pretty early, in the week 9 of fetal life. The size of premaxilla is an important indicator in the development of mid-facial complex. In humans, at birth, premaxillary region remains recognizable on maxilla, separated from it by premaxillary–maxillary suture and retains the ability of active osteogenesis, which is visible on palate and floor of nose. For these reasons, the size of spine nazalis anterior depends on the time of healing premaxillary–maxillary suture, which can have an impact on the growth of middle face. Nasal septum has an important, direct role in the growth of premaxilla, and thus an indirect role in the growth of maxilla. In accordance with the hypothesis of the septomedial traction in the growth of facial massif (middle face), the development process associated with malocclusion class III, can be associated with cartilaginous growth on septopresfenoidal joint [6]. Nasal capsule and nasal septum affect the forward movement of upper parts of maxilla, the expansion of space the lateral walls of nasal cavity and the development of premaxilla. Many authors are also convinced that vomero-palatine suture is important for anterior-inferior displacement of palatal bone. Traumatic nasomaxillary complex leads to abnormalities in the growth of nasal septum, and surrounding muscle dysfunction may affect the subsequent growth of the facial massif [7]. Accordingly, the growth of nasomaxillary complex is the result of two main mechanisms: passive transfer, which is due to the growth of cranial base, which “pushes” maxilla forward and active growth of maxillary and nasal structures. A growth model requires the face to grow “below the cranium”, which means that during growth and development, the jaw must be moved down and forward in relation to cranial base, thanks to the sutures by which it is attached to the cranial base. During this shift, the space to open on sutures is filled with the bone proliferation in these areas. Apposition of bone occurs on both sides of the suture, so that the bone to which maxilla is attached also becomes greater. In addition, the front structures of maxilla are subject to remodeling, so that almost its entire front surface is the resorption area [8]. Although cranial growth can affect the position of maxilla, maxillary growth takes place by translation, rotation and elongation within their skeletal dimensions. So, Marcus et al. [9] believe that maxillary growth in people is expressed in: the anterior translation of maxilla because of moving forward the anterior cranial base; pneumaticizing frontal sinuses and maxillary leaning forward; moving maxilla down; lateral shifting due to appositional growth on medium-palatal suture. Having said thath, the direction of growth of the upper jaw can influence the direction of eruption of upper permanent iucisors, which is an important early correction of their oral inclination [10, 11]. Deviations in the normal development of the maxillary complex can have a significant impact on the development of skeletal class III. This fact has focused our study in children with skeletal class III just on maxilla, as the anatomical structure whose prepubertal development, besides genetic predisposition, may be compromised by an often present adenoid problem and respiratory diseases that make it difficult to breath through the nose, which directly threatens the maxillary growth in children at this age.

Methods

The study used tele-x-ray profile head shots made in its natural position, with lateral teeth in maximum intercuspidity. The recordings are drawn through acetate paper, marking relevant cephalometric points, lines, planes and angles, which are used in the angular and linear measurements. The study included children with mixed dentition, aged 6–12, which were classified into two groups, 50 patients each, both sexes (25 males and 25 females). The first, test group, consisted of children with skeletal class III, selected on the basis of the value of angle ANB $\leq 0°$. The second, control group, consisted of children with skeletal class I, selected on the basis of normal values of angles of sagittal jaw position in relation to the cranial base, SNA = 80°–82°, SNB = 78°–80° and the angle of sagittal interjaw relationship, ANB = 2°–4° (Figure 1). The average age in the first group was 8 years and 9 months, in the second group, 9 years and three months. The patients from both groups were divided into subgroups according to age: the subgroup a – children aged 6–7 years and 11 months, subgroup b – children aged 8–9 years and 11 months and subgroup c – children aged 10–11 years and 11 months. Testing did not include the children with congenital anomalies, clefts and anodontia of some teeth. The length of

Fig. 1 – Angular cephalometric measurements for the selection into groups used in the study.

SNA – angle of sagittal maxillary position in relation to the cranial base anterior; SNB – angle of sagittal mandibulary position in relation to the cranial base anterior; ANB – angle of sagittal inter-jaw relationship

maxilla, mandible and cranial base were measured (Figure 2). Proportions among the lengths measured within each

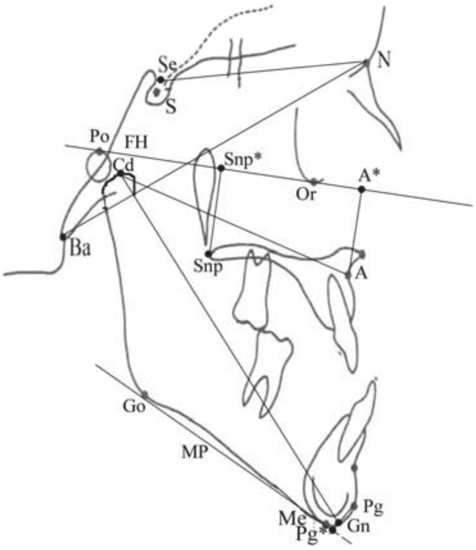

Fig. 2 – Cephalometric landmarks, reference lines and linear measurements for assessing maxillary length used in the study.

S – indicates sella (the center of sella turcica); Se – the center of apertura sella turcica; N – nasion (the most anterior limit of suture nasofrontalis); Ba – basion (the posterior inferior point of the occipital bone at the anterior margin of the foramen magnum); A – subspinale (the most posterior point on the concave anterior border of the maxillary alveolar process); A* – A point of contact of a perpendicular line drawn from point A to the FH; Snp – spina nasalis anterior (the apex of the anterior nasal spine); Snp* – a point of contact of a perpendicular line drawn from point Snp to the FH; Cd – condylion (the most posterior point on the outline of the mandibular condyle); Pg – pogonion (the most anterior point on the mandibular symphysis); Pg* – a point of contact of a perpendicular line drawn from point Pg to the MP; Gn – gnathion (the most anteroinferior point on the mandibular symphysis); Go – gonion (the most outward point on the angle formed by the junction of the ramus and body of the mandible on its posterior. inferior aspect); Me – menton (the lowermost point on the shadow of the mandibular symphysis); Po – porion (the superior aspect of the external auditory meatus); Or – orbite (the lower border of the orbit of the eye); NSe – length of anterior cranial base (Schwarz); NBa – total length of the cranial base;. CdA – total length of the upper jaw; A*Snp* – length of maxilla body; CdGn – total mandibular length; Pg*Go – mandibular body length.

group were found and difference significance in the measured lengths and their proportions among the groups and subgroups were evaluated. The results of measurement in children with skeletal class III were compared to the results of measuring the same parameters in children with skeletal class I, and to determine the difference significance of the obtained values test method Multiple Comparisons, Mann-Whitney and Wilcoxon test were used. Statistical interpretation was accepted on the probability level *$p \leq 0.05$ - significant, **$p \leq 0.01$ - highly significant, NS – $p > 0.05$ - no significant.

Results

Length of anterior cranial base (Nse) (Tables 1, 2)

Measuring the length of anterior cranial base in the group I of the patients, its average length of 72.20 mm was found in the range of values from 64.00 mm to 84.00 mm. In the group II of the patients, its length ranged from 64.00 mm to 82.00 mm, an average of 73.52 mm. The difference in the measured average values in the groups I and II was not statistically significant ($p > 0.05$). Significance of the difference in the values of this parameter in males and females, in the same age subgroups was not found in either of the groups ($p > 0.05$).

Total length of the cranial base (Nba) (Tables 1, 2)

Total length of the cranial base in the group I of the patients ranged from minimum 96.00 mm to a maximum of 121.00 mm, an average of 106.53 mm. Significance of the difference in the measured values in the patients of different sex was found only in the oldest subgroup ($p \leq 0.05$). In the group II of the patients, the measured total lengths of the cranial base ranged from 99.00 mm to 120.00 mm, an average of 109.06 mm. These values were significantly different from those measured in the patients of the group I ($p \leq 0.05$). The average values of the parameter NBa measured in the males and females of the same age subgroups were not significantly different ($p > 0.05$).

Total length of the upper jaw (CdA) (Tables 1, 2)

Total length of the upper jaw in the group I, ranged from minimum 75.00 mm to a maximum of 97.00 mm, an average value was 82.82 mm. The difference in average values of this parameter males and females of the same age subgroups was not significant ($p > 0.05$). In the group II of the patients, the values of total length of the upper jaw were measured, ranging from 75.00 mm to 99.00 mm, an average of 87.46 mm. These values were significantly different from those set forth in the group I ($p \leq 0.05$). The values of this parameter in the patients of different sexes were significantly different only in the oldest subgroup ($p \leq 0.05$).

*Length of maxilla body (A*Snp*) (Tables 1, 2)*

In the patients of the group I the values of the body length of the upper jaw were set in the interval from 39.00 mm to 52.00 mm, an average of 44.44 mm. Significance of the difference in the values of the measured parameter in the patients of different sexes of the same age subgroups was found only in the subgroup of the oldest ($p \leq 0.05$). Body length of the upper jaw in the group II of the patients was 47.52 mm on average, ranging from 41.00 mm to 54.00 mm, which was significantly different from the value of this parameter in the group I ($p \leq 0.05$). There was significant difference in its value in patients of different sexes of middle age subgroup ($p \leq 0.05$).

Total mandibular length (CdGn) (Tables 1, 2)

The average total length of mandible in the group I was 116.52 mm, and the measured values ranged from 105.00 mm to 141.00 mm. A significant difference of average total mandibular lengths in the patients of different sexes was not proven in either of the age groups ($p > 0.05$). In the patients of the group II, the average total mandibular length of 115.76 mm was found with ranging from 105.00 mm to 127.00 mm. These values were not significantly different from those in

Table 1

The parameters measured in the study and the results of the groups comparison

Parameters	Group	Min	Med	Max	x̄ ± SD	*p*
A*Snp*	1	39.00	44.50	52.00	44.44 ± 2.98	-3.08*
	2	41.00	47.00	54.00	47.52 ± 2.66	
CdA	1	75.00	82.00	97.00	82.82 ± 4.74	-4.64*
	2	75.00	88.00	99.00	87.46 ± 4.90	
Pg*Go	1	68.00	75.50	95.00	75.86 ± 4.94	-0.12
	2	66.00	76.00	85.00	75.98 ± 4.10	NS
CdGn	1	105.00	116.50	141.00	116.52 ± 7.10	0.76
	2	105.00	115.00	127.00	115.76 ± 5.69	NS
NSe	1	64.00	72.00	84.00	72.20 ± 4.18	-1.32
	2	64.00	73.50	82.00	73.52 ± 3.75	NS
NBa	1	96.00	106.00	121.00	106.53 ± 5.15	0.04*
	2	99.00	109.00	120.00	109.06 ± 4.71	

NS – no significant difference; * – significant difference (Method of multiple comparisons);
A*Snp*/NSe – Proportional relationships of body length of the upper jaw to the anterior cranial base;
A*Snp*/Pg*Go – Proportional relationship of body lenght of the upper jaw to mandibulan body length;
CdA/CdGn – Proportional relationship of the total lenght of the upper jaw to the total length of the lower jaw;
CdA/Nba – Proportional relationship of the total lenght of the upper jaw to the total length of the cranial base;
Min – minimal value; Med – median; Max – maximal value; x̄ –mean; SD – standard deviation;
group 1 – children with skeletal class III (test group); group 2 – children with skeletal class I (control group).

Table 2

The parameters measured in the study and the results of the subgroups comparison

Parameters	Group	Subgroup	x̄ ± SD		*p*
			M	F	
A*Snp*	1	a	44.67 ± 3.39	44.00 ± 2.19	0.63 (NS)
		b	44.50 ± 2.46	44.83 ± 3.71	0.89 (NS)
		c	45.78 ± 2.05	42.14 ± 3.13	0.03 *
	2	a	45.67 ± 5.03	45.75 ± 2.75	1.00 (NS)
		b	48.18 ± 2.71	46.15 ± 1.82	0.04 *
		c	49.09 ± 2.12	48.25 ± 2.12	0.48 (NS)
CdA	1	a	81.50 ± 4.55	82.00 ± 3.46	0.63 (NS)
		b	84.30 ± 3.86	82.17 ± 3.64	0.25 (NS)
		c	85.67 ± 6.50	80.00 ± 4.97	0.06 (NS)
	2	a	85.00 ± 4.58	85.50 ± 5.07	0.86 (NS)
		b	87.91 ± 5.89	85.23 ± 4.57	0.38 (NS)
		c	91.09 ± 3.96	87.38 ± 2.83	0.03 *
Pg*Go	1	a	74.33 ± 3.45	73.17 ± 3.66	0.81 (NS)
		b	76.70 ± 2.41	74.17 ± 4.39	0.10 (NS)
		c	81.11 ± 7.37	74.43 ± 1.13	0.01 **
	2	a	74.33 ± 2.08	72.50 ± 5.32	0.59 (NS)
		b	75.73 ± 4.78	74.62 ± 4.17	0.73 (NS)
		c	79.18 ± 2.44	76.50 ± 2.27	0.04 *
CdGn	1	a	112.33 ± 4.63	113.50 ± 4.76	0.75 (NS)
		b	119.60 ± 5.25	114.25 ± 7.12	0.09 (NS)
		c	121.11 ± 10.22	116.29 ± 4.07	0.43 (NS)
	2	a	114.33 ± 5.03	113.00 ± 5.10	0.72 (NS)
		b	116.27 ± 5.02	112.23 ± 5.76	0.06 (NS)
		c	121.18 ± 4.47	115.25 ± 3.41	0.01 *
NSe	1	a	73.17 ± 4.02	71.67 ± 2.07	0.63 (NS)
		b	73.90 ± 2.42	71.42 ± 3.80	0.05 *
		c	74.33 ± 6.04	68.00 ± 2.65	0.03 *
	2	a	71.00 ± 3.61	74.00 ± 2.31	0.27 (NS)
		b	73.82 ± 4.31	71.46 ± 3.82	0.21 (NS)
		c	75.91 ± 3.36	73.88 ± 2.23	0.16 (NS)
NBa	1	a	105.33 ± 4.18	103.50 ± 2.59	0.52 (NS)
		b	107.70 ± 2.98	106.67 ± 6.13	0.35 (NS)
		c	111.13 ± 6.36	103.00 ± 2.71	0.02 *
	2	a	108.33 ± 2.08	108.25 ± 4.92	0.86 (NS)
		b	109.18 ± 5.65	106.92 ± 4.66	0.50 (NS)
		c	112.09 ± 3.53	108.88 ± 4.36	0.08 (NS)

NS – no significant difference; * – significant difference; ** (Mann–Whitney and Wilcoxon test)
A*Snp* - length of maxilla body; CdA – total length of the upper jaw; Pg*Go – mandibular body length;
CdGn – total mandibular length; Nse – length of anterior cranial base; Nba – total length of the cranial base; M – male; F – female; x̄ – mean; SD – standard deviation; group 1 – children with skeletal clas III (test group); group 2 – children with skeletal class I (control group); a – children aged 6–7 years and 11 months; b – children aged 8–9 years and 11 months; c – children aged 10–11 years.

the group I ($p > 0.05$). A significant difference in the values of this parameter in the patients of different sexes was found in the oldest subgroup ($p \leq 0.01$).

*Mandibular body length (Pg*Go) (Tables 1, 2)*

The patients of the group I had an average mandibular length of 75.86 mm, and the measured values were within the range of 68.00 mm to 95.00 mm. A significant difference of the measured values was found in the oldest subgroup of male and female patients ($p \leq 0.05$). In the patients of the group II, the measured mandibular body lengths ranged from 66.00 mm to 85.00 mm, the average of 75.98 mm. A significant difference was not found in the values of this parameter in the tested groups ($p > 0.05$). A significant difference in the measured values of this parameter in the patients of different sexes was found in the oldest subgroup ($p > 0.05$).

*Proportional relationship of body length of the upper jaw to the anterior cranial base (A*Snp*/Nse) (Tables 3, 4)*

The average value of this proportion in the group I was 0.62, and the measured values ranged from 0.54 to 0.72. In the patients of the group II, its average value of 0.65 was established with the measured values ranging from 0.60 to 0.71. These values were significantly different from those in the group I ($p \leq 0.05$). There was no significant difference in the values of this proportion in the patients of different sexes, or in any age subgroup, test or control group ($p > 0.05$).

*Proportional relationship of body length of the upper jaw to mandibular body length (A*Snp*/Pg*Go) (Tables 3, 4)*

In the patients of the group I, the measured values of this proportional relationship ranged from 0.49 to 0.71, with

Table 3

The proportional relationships measurements and the results of the groups comparison

Proportional relationships	Group	Min	Med	Max	x̄ ± SD	p
A*Snp*/NSe	1	0.56	0.62	0.72	0.62 ± 0.04	0.03*
	2	0.60	0.65	0.71	0.65 ± 0.03	
A*Snp*/Pg*Go	1	0.49	0.58	0.71	0.59 ± 0.04	0.04*
	2	0.55	0.63	0.68	0.63 ± 0.03	
CdA/CdGn	1	0.65	0.72	0.77	0.71 ± 0.03	0.04*
	2	0.69	0.76	0.80	0.76 ± 0.03	
CdA/NBa	1	0.72	0.77	0.85	0.78 ± 0.03	0.02*
	2	0.72	0.80	0.87	0.80 ± 0.03	

*** significant difference (Method of multiple comparisons) A*Snp* - length of maxilla body; CdA – total length of the upper jaw; Pg*Go – mandibular body length; CdGn – total mandibular length; Nse – Length of anterior cranial base; Min – minimal value; Med – median; Max – maximal value; x̄ –mean; SD – standard deviation; group 1 – children with skeletal class III (test group); group 2 – children with skeletal class I (control group).**

Table 4

The proportional relationships measurements and the results of the subgroups comparison

Proportional relationships	Group	Subgroup/years	x̄ ± SD M	x̄ ± SD F	p
A*Snp*/NSe	1	a	0.61 ± 0.03	0.62 ± 0.03	0.69 (NS)
		b	0.60 ± 0.04	0.63 ± 0.05	0.27 (NS)
		c	0.62 ± 0.04	0.62 ± 0.04	0.83 (NS)
	2	a	0.64 ± 0.06	0.62 ± 0.02	0.71 (NS)
		b	0.65 ± 0.03	0.65 ± 0.03	0.68 (NS)
		c	0.65 ± 0.03	0.65 ± 0.03	0.71 (NS)
A*Snp*/Pg*Go	1	a	0.60 ± 0.06	0.61 ± 0.06	0.87 (NS)
		b	0.58 ± 0.03	0.61 ± 0.04	0.11 (NS)
		c	0.57 ± 0.04	0.57 ± 0.04	0.56 (NS)
	2	a	0.62 ± 0.06	0.63 ± 0.04	0.86 (NS)
		b	0.64 ± 0.03	0.62 ± 0.03	0.10 (NS)
		c	0.62 ± 0.03	0.63 ± 0.04	0.26 (NS)
CdA/NBa	1	a	0.77 ± 0.03	0.79 ± 0.02	0.20 (NS)
		b	0.78 ± 0.05	0.77 ± 0.02	0.77 (NS)
		c	0.77 ± 0.04	0.78 ± 0.04	0.75 (NS)
	2	a	0.78 ± 0.04	0.79 ± 0.05	0.71 (NS)
		b	0.80 ± 0.04	0.80 ± 0.03	0.95 (NS)
		c	0.81 ± 0.03	0.80 ± 0.03	0.43 (NS)
CdA/CdGn	1	a	0.73 ± 0.03	0.72 ± 0.03	0.63 (NS)
		b	0.71 ± 0.03	0.72 ± 0.02	0.18 (NS)
		c	0.71 ± 0.02	0.69 ± 0.03	0.11 (NS)
	2	a	0.74 ± 0.03	0.76 ± 0.04	0.48 (NS)
		b	0.76 ± 0.03	0.76 ± 0.03	0.68 (NS)
		c	0.76 ± 0.02	0.76 ± 0.02	0.56 (NS)

NS – no significant difference (Mann-Whitney and Wilcoxon test) A*Snp*/Nse – Proportional relationships of body length of the upper jaw to the anterior cranial base; A*Snp*/Pg*Go – Proportional relationships of body length of the upper jaw to the mandibular body length; CdA/Nba – Proportional relationships of the total length of the cranial base; CdA/CdGn – Proportional relationships of body length of the lower jaw M – male; F – female; x̄ – mean; SD – standard deviation; group 1 – children with skeletal clas III (test group); group 2 – children with skeletal class I (control group); a – children aged 6–7 years and 11 months; b – children aged 8–9 years and 11 months; c – children aged 10–11 years.

the average of 0.59. The patients of the group II had the average value of the proportion A*Snp*/Pg*Go of 0.63, ranging from 0.55 to 0.68. These values were significantly different from those in the patients of the ($p \leq 0.05$). A significant difference in the average values of the tested proportional relationship was not found in the patients of different sexes within the same age groups, test or control group ($p > 0.05$).

Proportional relationship of the upper – lower jaws total length (CdA/CdGn) (Tables 3, 4)

The set values of the proportional relationship in the group I of patients ranged from 0.65 to 0.77, with the average of 0.71. The results of measuring the proportion CdA/CdGn in the patients of the group II were significantly different from those found in the group I ($p \leq 0.05$). Its values in the group II ranged from 0.69 to 0.80. The average value for the whole group was 0.76. As in the group I, there was no significant difference in the measured values in the patients of different sexes, belonging to the same age subgroups ($p > 0.05$).

Proportional relationship of the total length of the upper jaw to the total length of the cranial base (CdA/Nba) (Tables 3, 4)

By measuring this proportional relationship in the group I of the patients values ranged from 0.72 to 0.85, with the average of 0.78, were found. In the group II of the patients, the same proportion ranged from 0.72 to 0.87, with the average of 0.80, which was significantly different from values in the group I ($p \leq 0.05$). A significant difference in the values of the tested proportional relationship among the members of different sexes, within the same age groups, was not found in either of the groups ($p > 0.05$).

Discussion

Data from the literature indicate that the size and proportion of the maxilla are the major etiological factor during its growth for skeletal class III development. The authors often point out that the maxillary retrognatism is usually masked and cannot be recorded through angular analysis, due to the changed length and angulations of the cranial base, which affect the position of the point nasion, directly responsible for the size of many indicators of sagittal maxillary position (SNA, FHNA, ANV...) [11–13]. Therefore, some authors prefer to use linear measures, which do not represent actual anatomical length of the jaw bones, but a linear distance from the tip of the condylary process to the body limit of the jaw bone and its alveolar processus (total length), or the distance between the farthest anatomical points, or their structures, which limit the bodies of the jaw bones. However, those sizes are very individual and depend on age, sex and physical dimensions of patients, so that their absolute values do not say much. We get much more data when we look at these sizes compared to the total length of the cranial base and the total length of the other jaw bone, thus determining its relative or proportional value. It is accepted that the proportion of length of the upper jaw body should be a 7/10 length of NSe (A*Snp*/NSe = 0.7) and 2/3 length of the lower jaw body (A*Snp*/Pg*Go = 0.67). In the literature, we find conflicting opinions on the issue of finding the total length and body length of the maxilla in patients with skeletal class III during growth. Thus, the results of maxilla length in children during primary dentition show that there is a highly significant difference in its size in children with skeletal class III, where its body is shorter, compared to children with skeletal class I [14]. The results of measurements of maxilla total length show that it is shorter in patients with skeletal class III than in those with skeletal class I, in all age groups from 6 to 16, but that the difference in its length is not statistically significant [15]. Neither the results of maxilla total length measurements in a study performed in Korean children with primary dentition indicate significant differences between the measured lengths in children with skeletal class I and those with skeletal class III [16]. The research conducted on adult patients with skeletal class III found the existence of significantly lower total maxillary length, compared to patients with skeletal class I [17]. In our study, the group with skeletal class III showed significantly lower values of the body length and total maxillary length, both their absolute values (A*Snp*, CdA), and relative values in relation to the cranial base (A*Snp*/NSe, CdA/NBa) and the mandibular length (A*Snp*/Pg*Go, CdA/CdGn) as compared to children with skeletal class I. Proportional relationships CdA/NBa, A*Snp*/NSe are, apart from a reduced maxillary length, additionally distorted by significantly lower total length of the cranial base, and the length of the anterior cranial base, which is lower in the group with skeletal class III, although the difference compared to the results of the control group is not significant. Irregularities of the tested proportions, A*Snp*/Pg*Go, CdA/CdGn can be considered to be the sole consequence of significantly lower maxillary lengths, since mandibular lengths were not significantly changed in children with skeletal class III, also shown by the results of our previous studies [18]. The degree of proportion irregularities of total maxillary and mandibular lengths is considered to be an important factor in predicting effectiveness of the therapy, so if it is very high, it is a bad prognostic sign [19]. Therefore, the application of orthodontic and orthopedic appliances to encourage sagittal maxillary growth in the period of mixed dentition is imposed as an imperative. In patients of different sex within the same age subgroups, significant differences of the values of some tested parameters were found, both in the group with skeletal class III and in the group with skeletal class I. It is interesting that a significant difference in the values of absolute and not proportional jaw lengths was found. In children with skeletal class I, the total lengths of both jawbones and mandibular body length were significantly higher in male patients in the oldest, and maxillary body length in the middle age subgroup. In children with skeletal class III, the body length of both jawbones were significantly higher in male patients in the oldest subgroup, while a significant difference in their total lengths was not found in either of the age subgroups. Data on the value of total maxillary length, measured in a longitudinal study on growth in children with normal occlusion at the age of 6, 9, 12, 14, 16 and 18, indicate its greater length in male patients of all age groups, but also that the difference in length becomes significant only from the age of 14, when in female patients the growth in the length stagnates, and in male patients it continues after the tested period [20]. Similar information is also found in the longitudinal study of growth in untreated patients with skeletal class III, of the same age interval, where significantly higher total length of maxilla in the male patients can be found only at the age of 13 and over [21]. A significant difference in maxillary length among patients of different sexes also depends on ethnicity. The results of comparative studies in Chinese and Caucasian patients with normal occlusion show that in both ethnic groups in female patients a significantly lower total maxillary length and significantly greater difference between the total jaw lengths than in male patients were found [22]. In the oldest subgroups of the test and control groups of children, significantly higher mandibular body length in male patients was found. In children with skeletal class III, difference significance of the measured mandibular total lengths among patients of different sexes within the same age subgroups was not found while in the group with skeletal class I, in the oldest subgroup, a significantly higher mandibular total length in male patients was found. A significant difference of the measured average lengths of the cranial base in patients of different sexes was found only in the group with skeletal class III, for the values of anterior cranial base in the middle and oldest groups, and for the values of total length of the cranial base, in the oldest subgroup, where male patients had significantly higher length of these parameters. These findings clearly indicate the existence of sexual dimorphism in terms of linear lengths of various anatomical structures of the craniofacial complex. In the same age subgroups, in children with skeletal classes I and III, there was a significant difference in linear values of maxillary but not mandibulary lengths. This finding could be explained by the fact that mandibular growth, usually longer than the length of maxillary growth, lasts longer in patients with skeletal class III, since studies show that the pubertal peak of growth in them is also significantly longer, for about five months [23]. Therefore, a significant difference of mandibular lengths could be expected only before the end of the pubertal peak, when the results of application of functional orthodontic and orthopedic appliances for modification of the growth type are already very limited. For these reasons, the estimated lower maxillary lengths, could be considered an early indicator of development of skeletal class III and important signal for the start of its timely treatment.

Conclusion

The results obtained in the study show that children with skeletal class III have significantly lower maxillary length than children with skeletal class I. Children with skeletal class III, compared to children with skeletal class I, have a lower absolute maxillary body length, lower total maxillary length, lower maxillary body length proportional to the lengths of anterior cranial base and mandibular body, and lower total maxillary length proportional to the total lengths of the cranial base and mandible. Comparing the results of measuring the proportional maxillary lengths in patients of different sex, in the same age subgroups, a significant difference was not found, while significantly higher lengths in male patients were found for the absolute values of the measured parameters.

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